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**Chen**

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(54) **FUNCTIONAL FILM, ENVIRONMENTALLY SENSITIVE ELECTRONIC DEVICE PACKAGE, AND MANUFACTURING METHODS THEREOF**

(71) Applicant: **Industrial Technology Research Institute, Hsinchu (TW)**

(72) Inventor: **Kuang-Jung Chen, Hsinchu County (TW)**

(73) Assignee: **Industrial Technology Research Institute, Hsinchu (TW)**

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CPC ..... **H01L 51/5246** (2013.01); **H01L 2251/5338** (2013.01); **H01L 2924/0002** (2013.01); **Y10T 156/10** (2015.01); **Y10T 156/109** (2015.01); **Y10T 428/1476** (2015.01)

(58) **Field of Classification Search**  
None  
See application file for complete search history.

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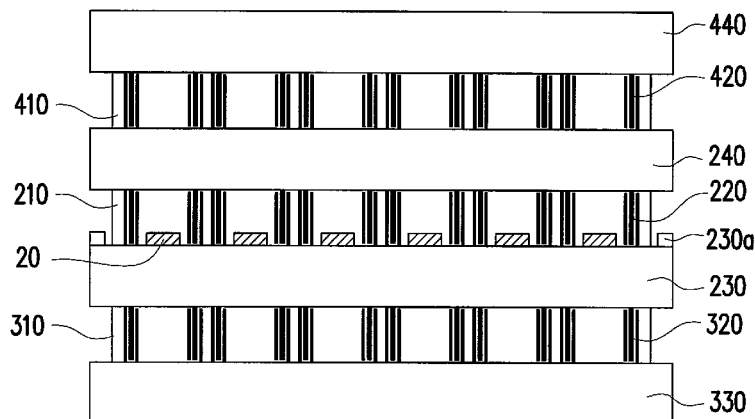
*Primary Examiner* — Anthony Ho  
*Assistant Examiner* — Samuel Lair

(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

An environmentally sensitive electronic device package including a first adhesive, at least one first side wall barrier, a first substrate, and a second substrate is provided. The first adhesive has a first surface and a second surface opposite to the first surface. The first side wall barrier is distributed in the first adhesive. The first substrate is bonded with the first surface. The first substrate has an environmentally sensitive electronic device formed thereon and the environmentally sensitive electronic device is surrounded by the first side wall barrier. The second substrate is bonded with the second surface. A manufacturing method of the environmentally sensitive electronic device package is also provided.

**13 Claims, 13 Drawing Sheets**



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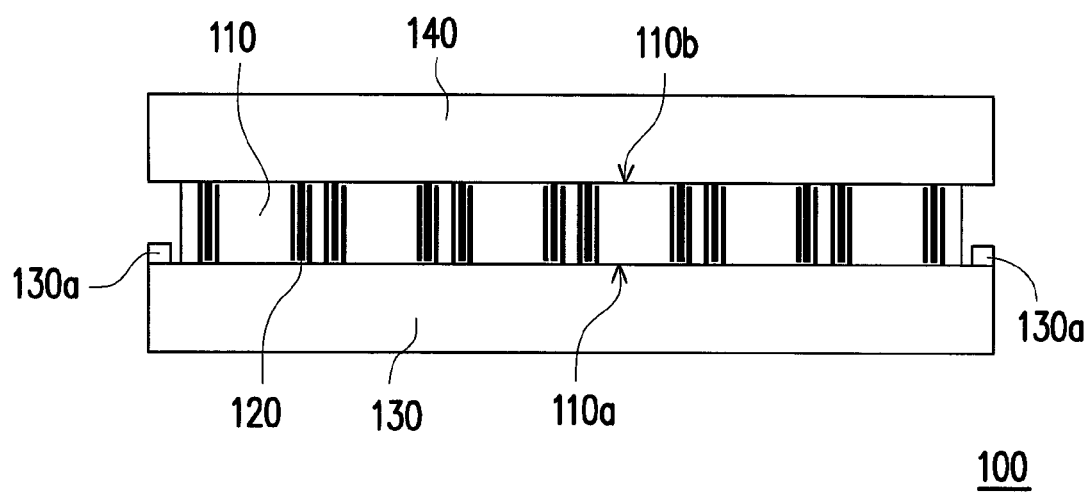


FIG. 1A

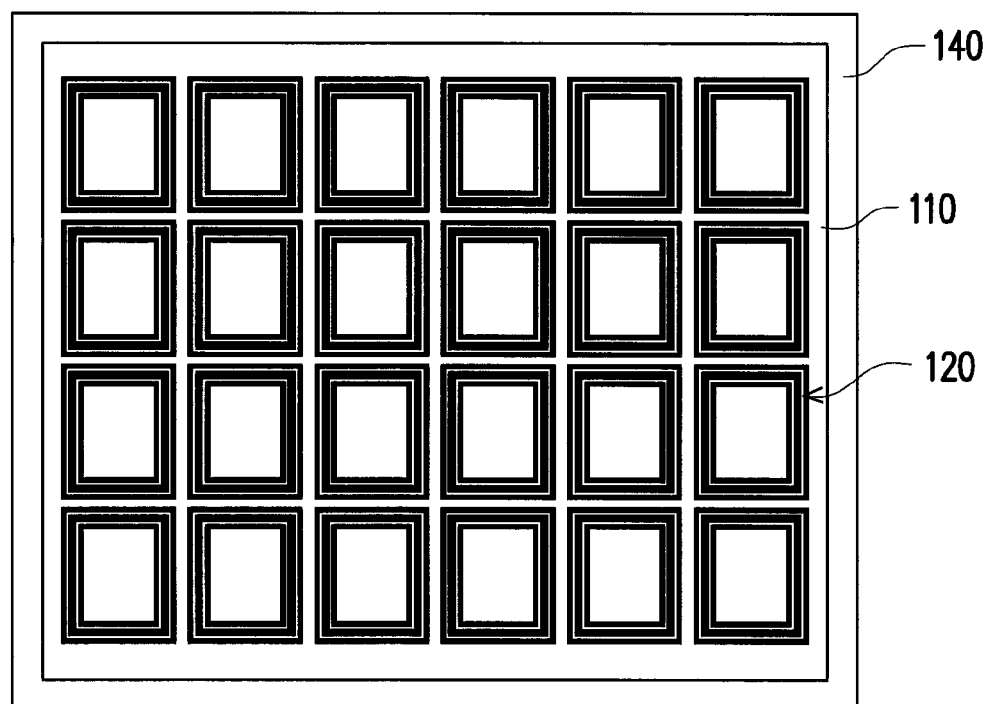


FIG. 1B

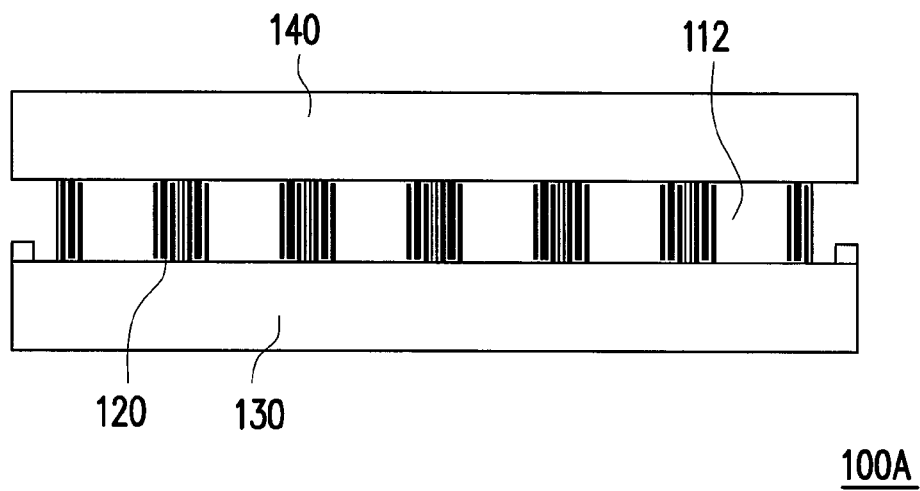


FIG. 2A

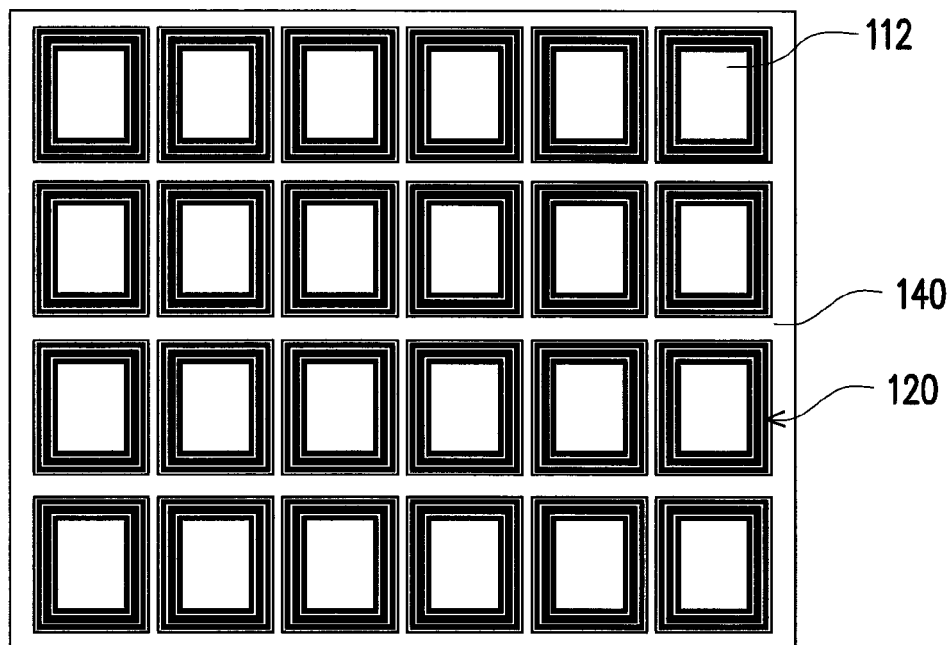


FIG. 2B

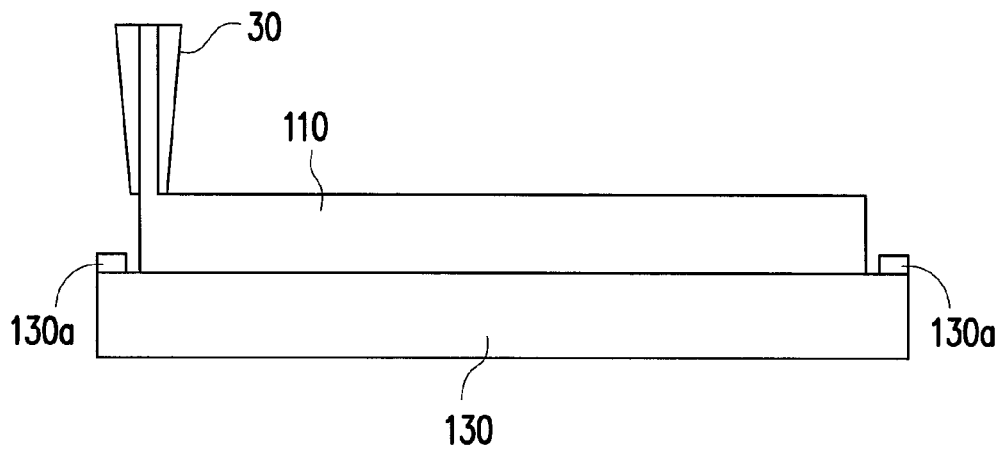


FIG. 3A

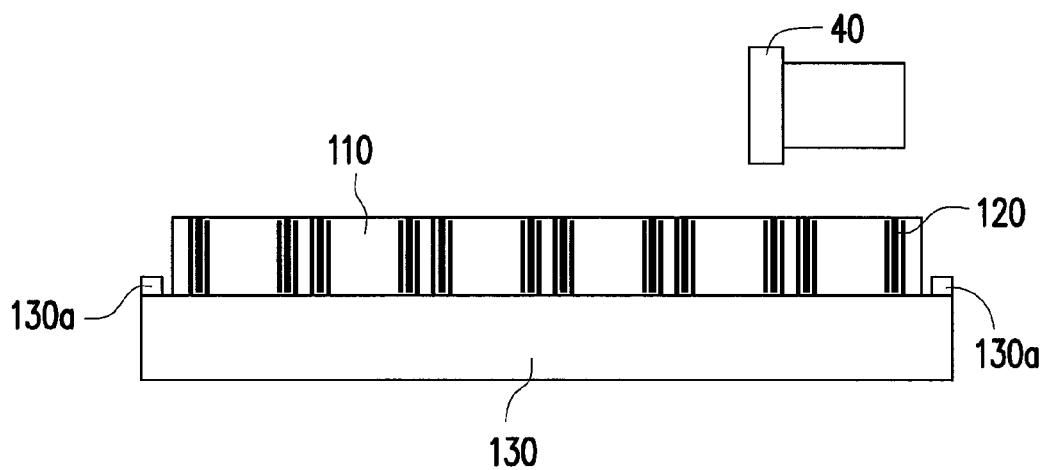


FIG. 3B

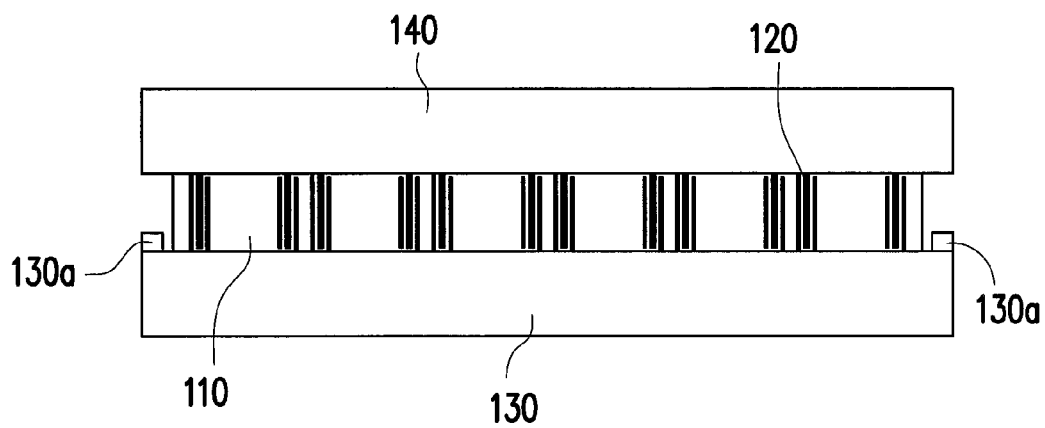


FIG. 3C

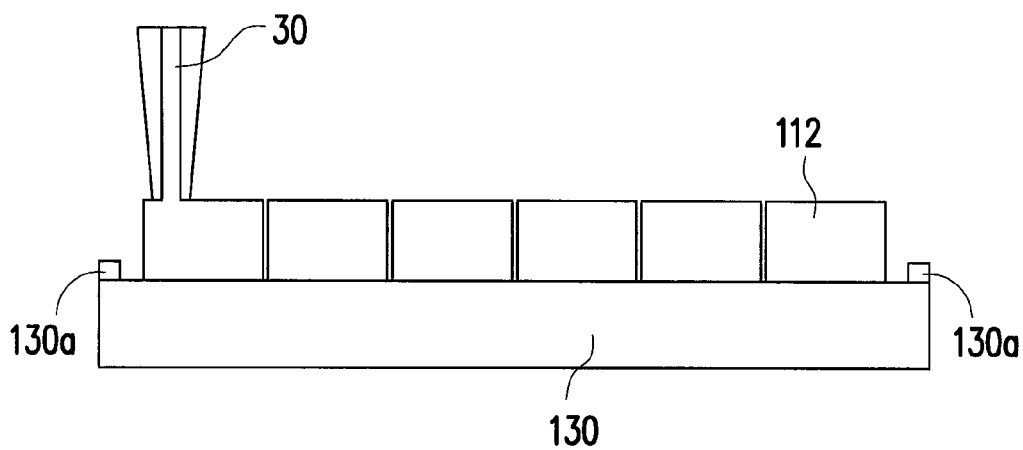


FIG. 3A'

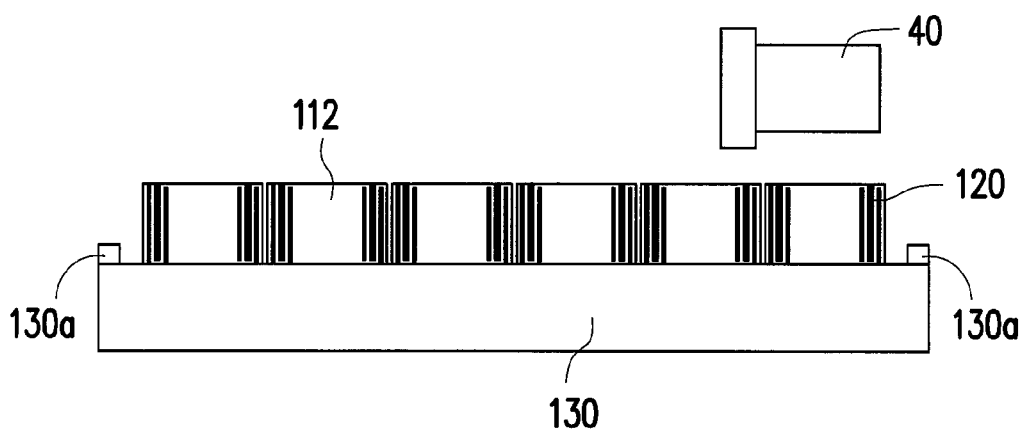


FIG. 3B'

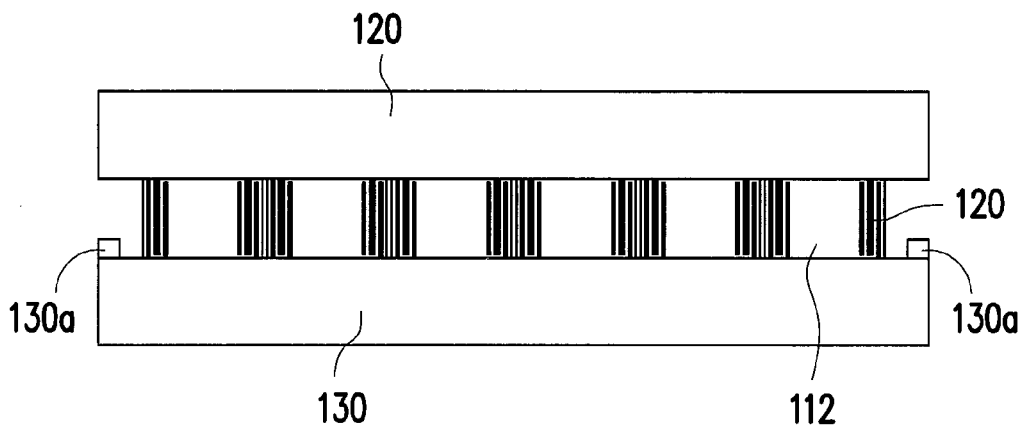


FIG. 3C'

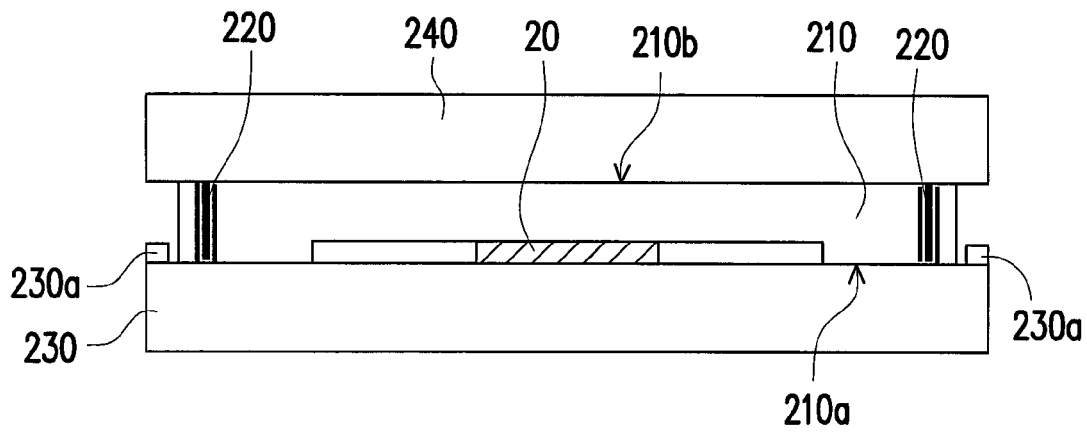


FIG. 4A

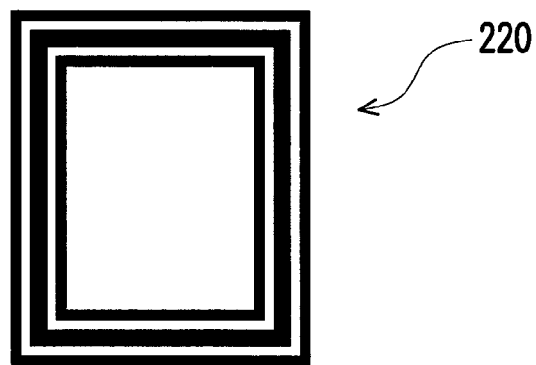


FIG. 4B

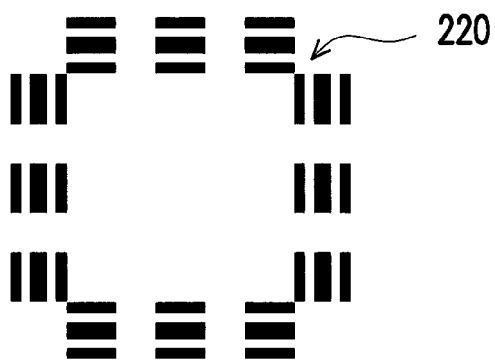


FIG. 4C

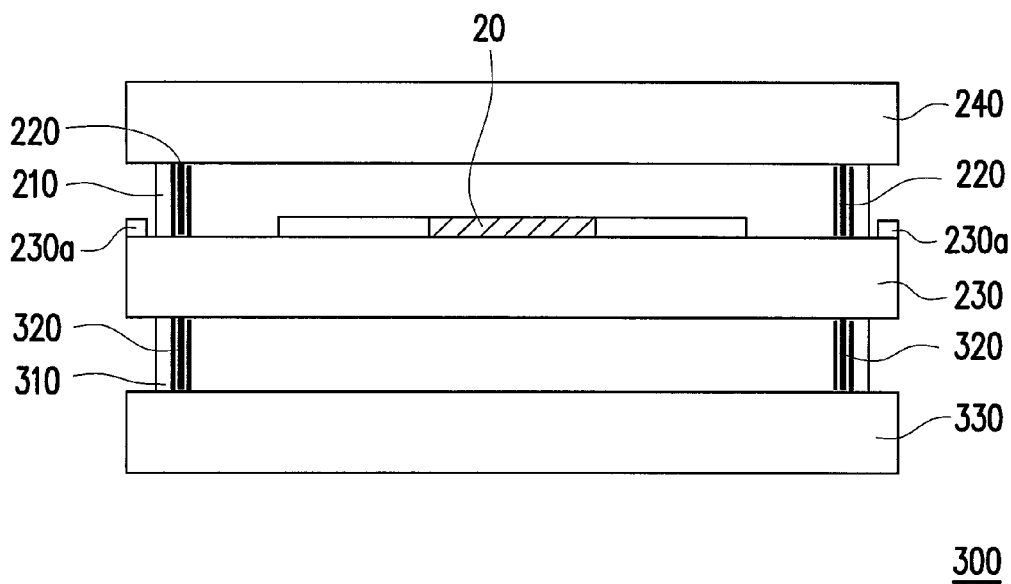


FIG. 5

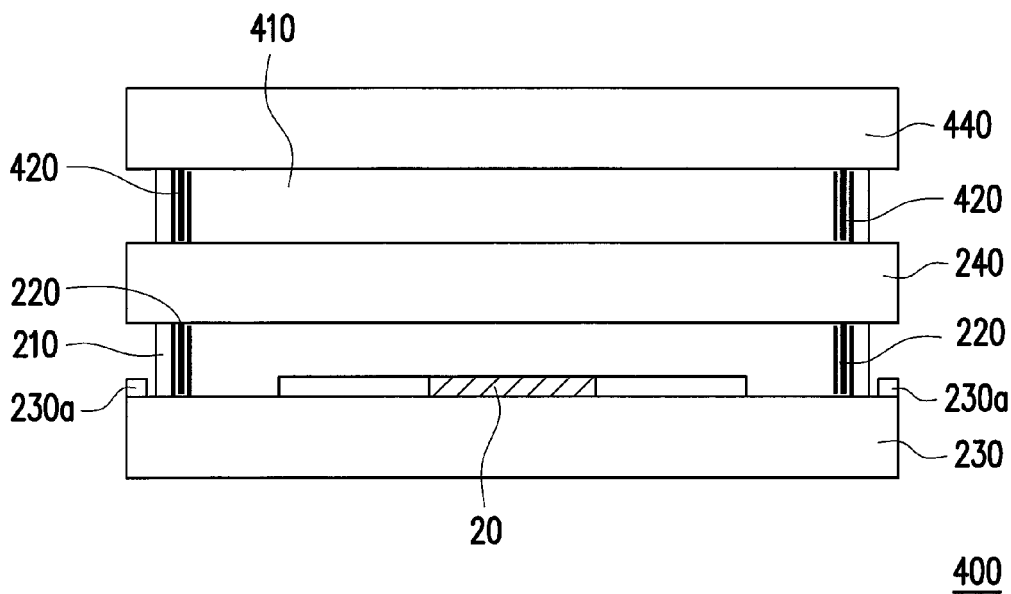


FIG. 6



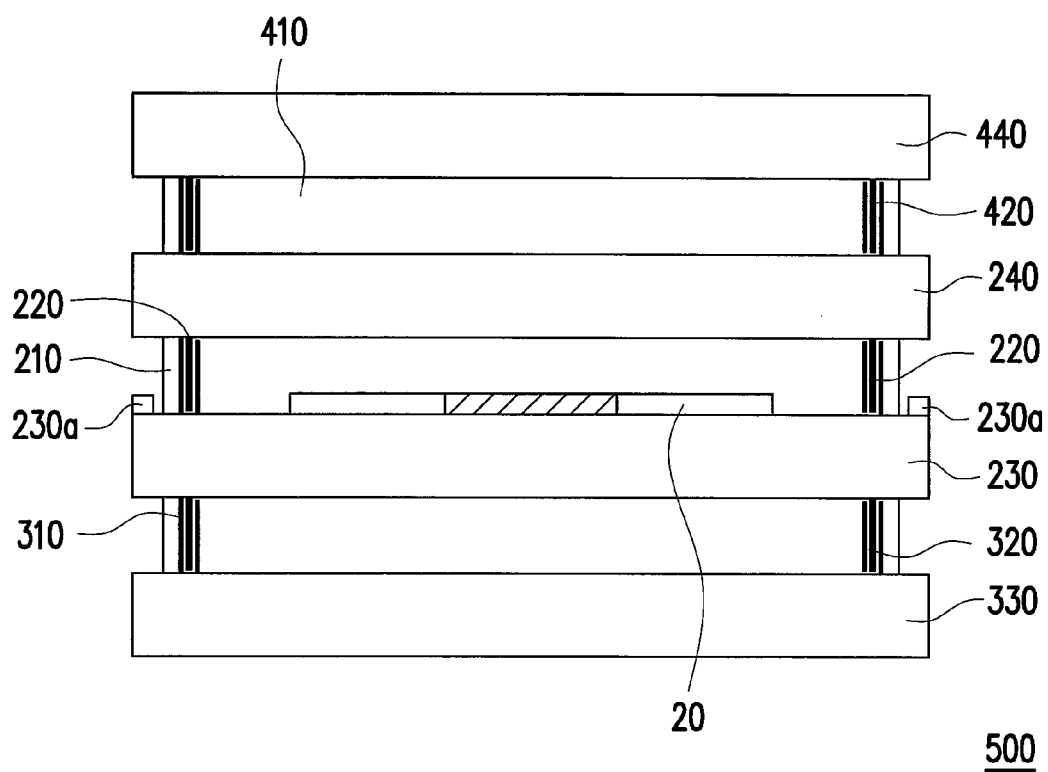


FIG. 7

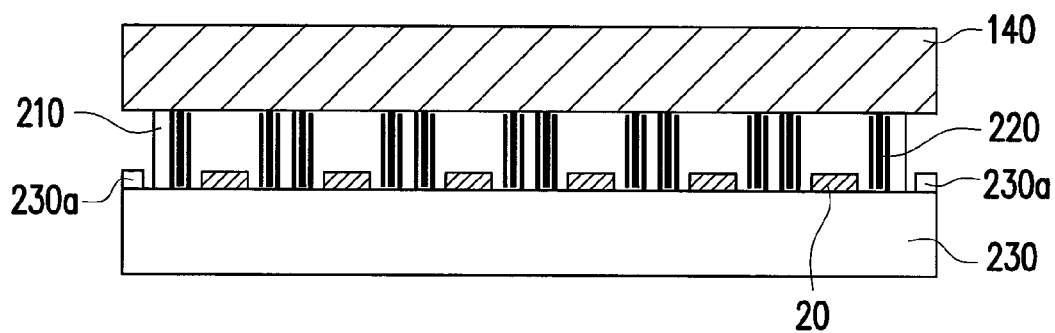


FIG. 8A

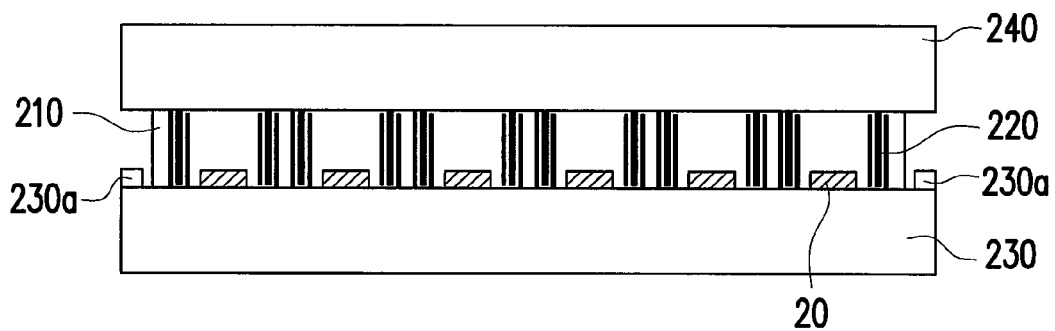


FIG. 8B

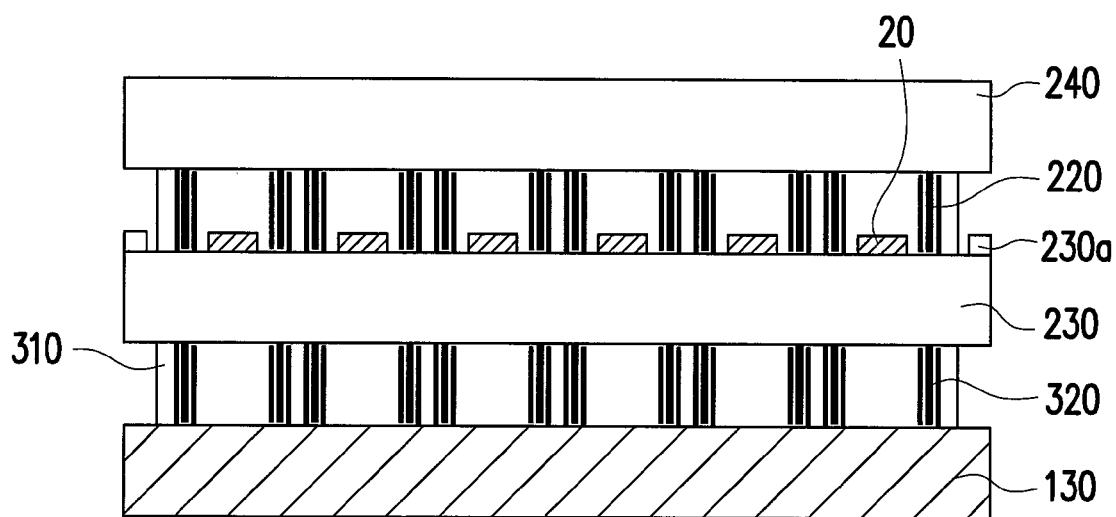


FIG. 8C

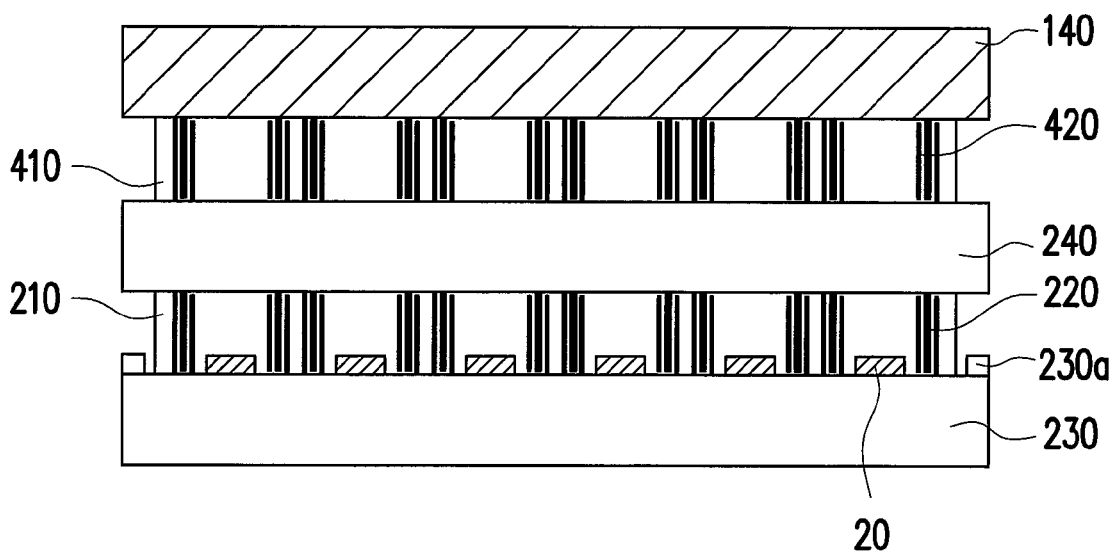


FIG. 8C'

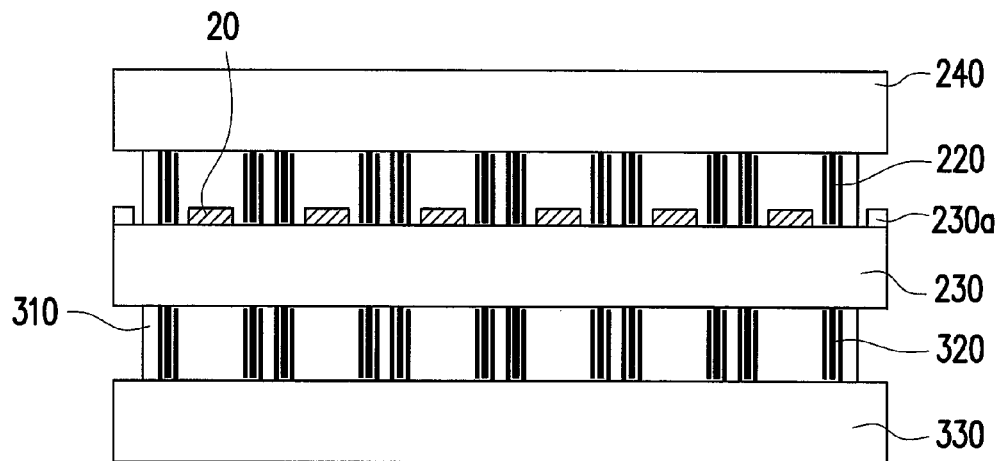


FIG. 8D

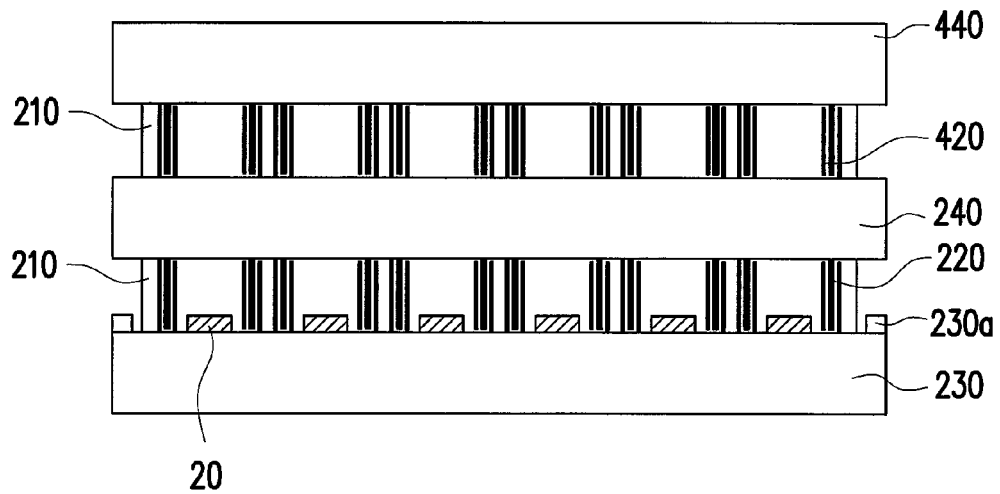


FIG. 8D'

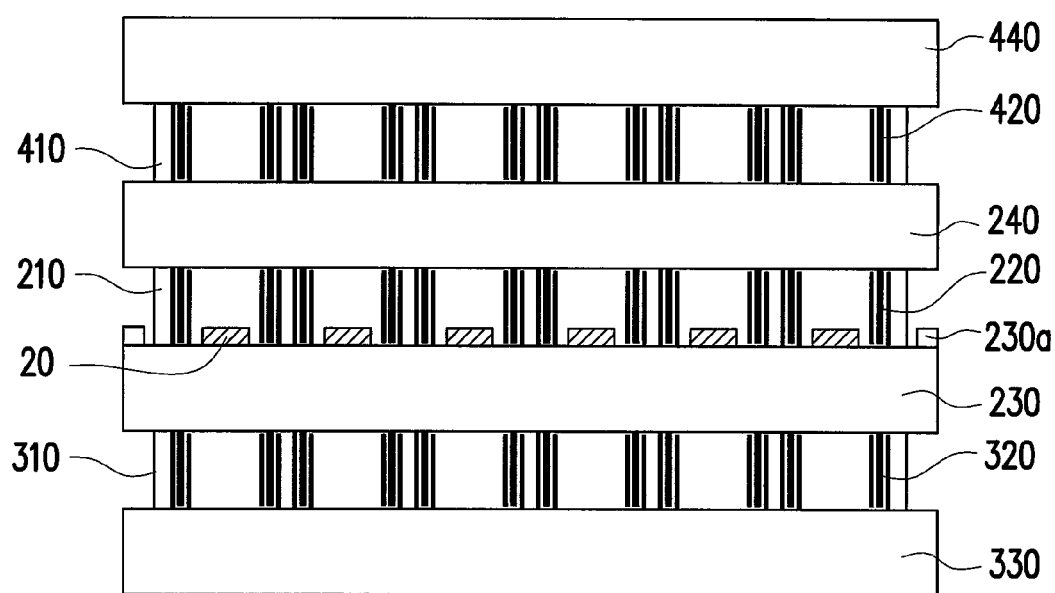


FIG. 8E

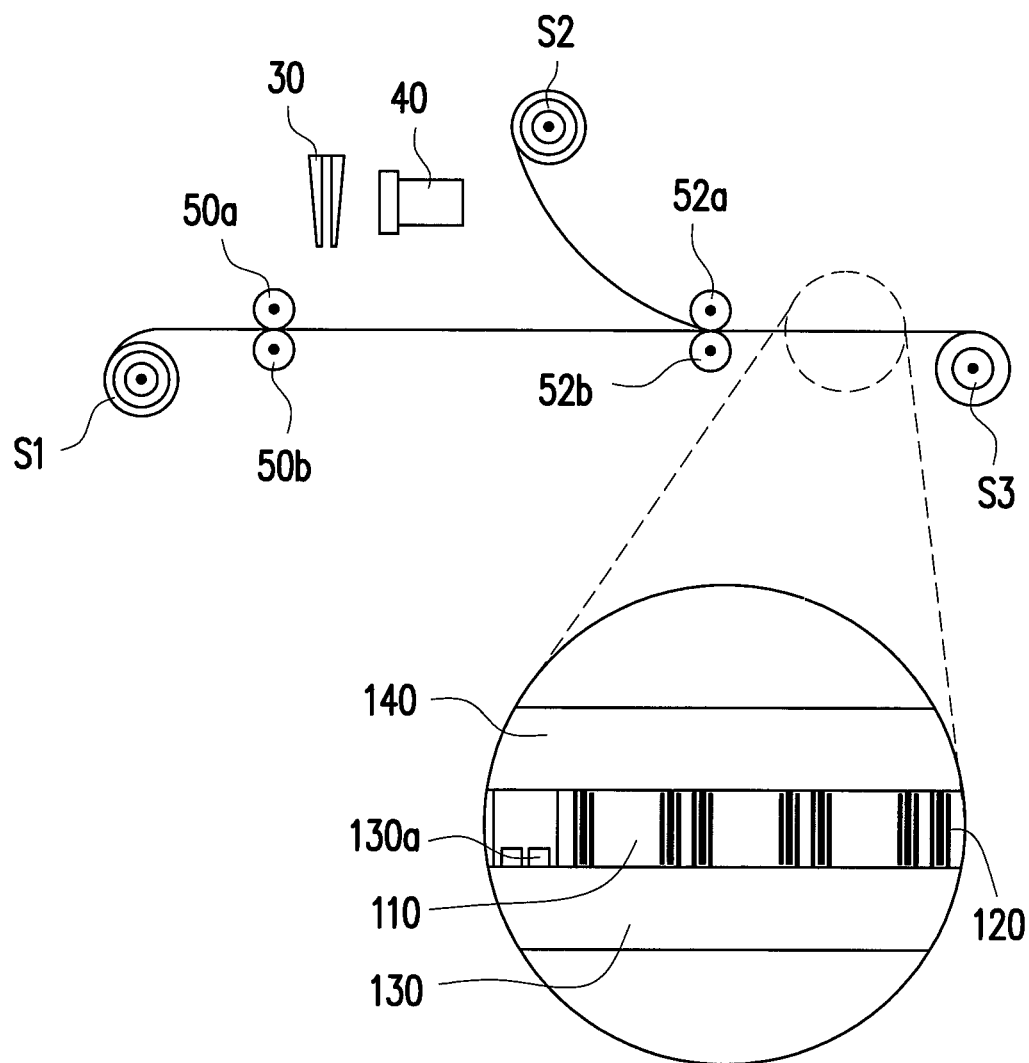


FIG. 9

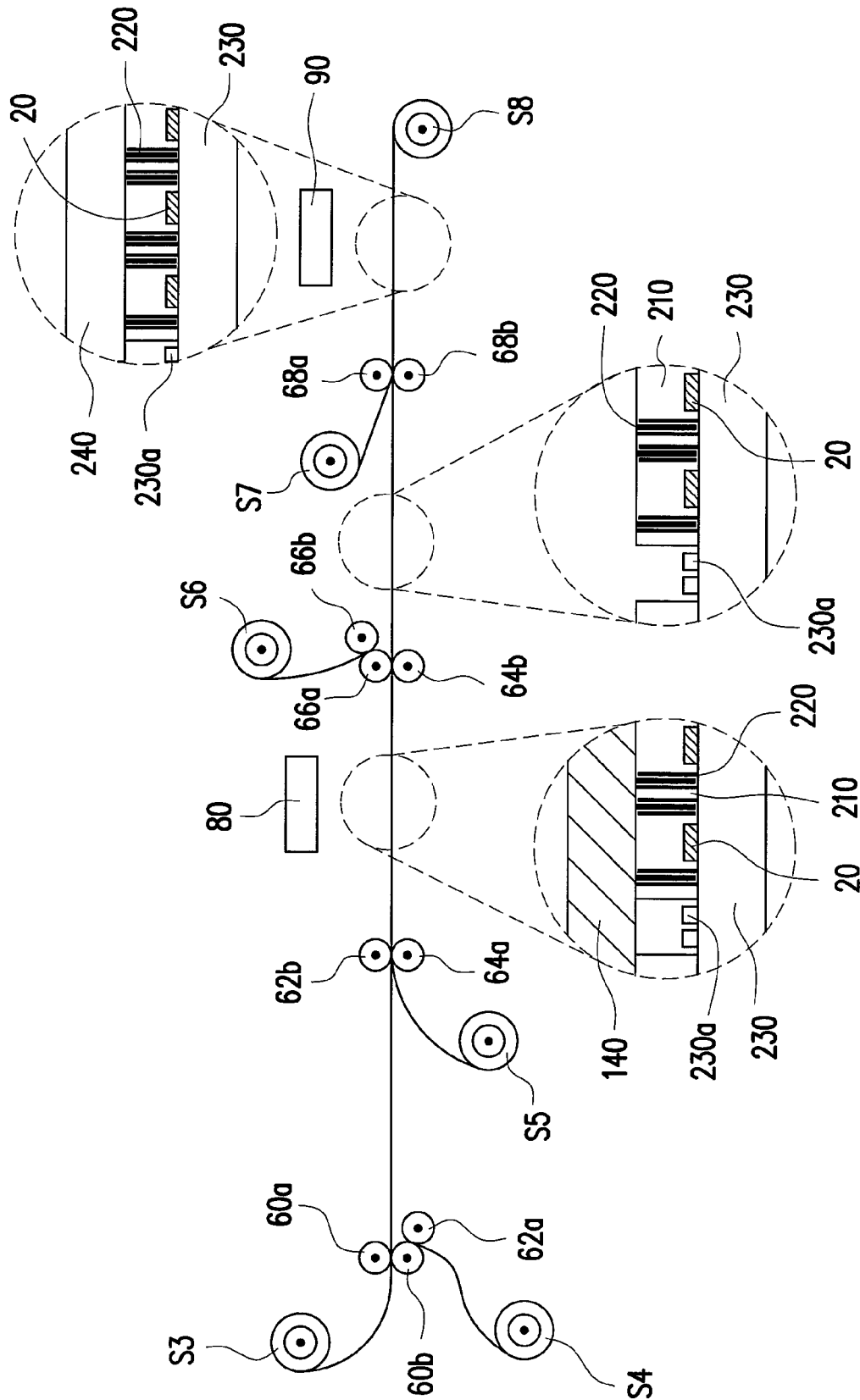


FIG. 10

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# FUNCTIONAL FILM, ENVIRONMENTALLY SENSITIVE ELECTRONIC DEVICE PACKAGE, AND MANUFACTURING METHODS THEREOF

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 101147602, filed on Dec. 14, 2012. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

## TECHNICAL FIELD

The technical field relates to a package and a manufacturing method thereof, and more particularly, to an environmentally sensitive electronic device package and a manufacturing method thereof.

## BACKGROUND

Compared to general rigid substrates, flexible substrates are more broadly used for they are windable, portable, secure, and widely applicable. However, flexible substrates also come with some disadvantages. For example, flexible substrates are not heat resistant or chemical resistant and offer low moisture and oxygen barrier properties and large coefficients of thermal expansion. A typical flexible substrate can be adopted for carrying electronic devices and/or packaging the electronic devices as a cover. Because a flexible substrate cannot completely obstruct the passage of moisture and oxygen, the moisture and oxygen will speed up the aging of the electronic devices on the flexible substrate and accordingly the lifespan of the electronic devices will be shortened undesirably.

## SUMMARY

The disclosure provides a functional film and a manufacturing method thereof, so as to offer good moisture and oxygen obstruction capability.

The disclosure further provides an environmentally sensitive electronic device package and a manufacturing method thereof, so as to offer good moisture and oxygen obstruction capability.

The disclosure provides a functional film including an adhesive, at least one side wall barrier, and a first de-bonding film. The adhesive has a first surface and a second surface opposite to the first surface. The side wall barrier is distributed in the adhesive. The first de-bonding film is adhered with the first surface.

The disclosure provides a manufacturing method of a functional film. The manufacturing method includes following steps. An adhesive is formed on a first de-bonding film. At least one side wall barrier is then formed in the adhesive.

The disclosure provides an environmentally sensitive electronic device package including a first adhesive, at least one first side wall barrier, a first substrate, and a second substrate. The first adhesive has a first surface and a second surface opposite to the first surface. The first side wall barrier is distributed in the first adhesive. The first substrate is bonded with the first surface, wherein at least one environmentally sensitive electronic device is disposed on the first substrate. The second substrate is bonded with the second surface.

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The disclosure provides a manufacturing method of an environmentally sensitive electronic device package. The manufacturing method includes following steps. A first adhesive is formed on a first substrate so that the first adhesive is bonded with the first substrate, wherein at least one environmentally sensitive electronic device is disposed on the first substrate. At least one first side wall barrier is then formed in the first adhesive. A second substrate is bonded with the first adhesive so that the first adhesive is between the first substrate and the second substrate.

Several exemplary embodiments accompanied with figures are described in detail below to further describe the disclosure in details.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments and, together with the description, serve to explain the principles of the disclosure.

FIG. 1A is a cross-sectional view of a functional film according to a first embodiment of the disclosure.

FIG. 1B is a top view of the functional film in FIG. 1A.

FIG. 2A is a cross-sectional view of another functional film according to the first embodiment of the disclosure.

FIG. 2B is a top view of the functional film in FIG. 2A.

FIGS. 3A-3C are diagrams illustrating a manufacturing method of the functional film in FIG. 1A.

FIGS. 3A'-3C' are diagrams illustrating a manufacturing method of the functional film in FIG. 2A.

FIG. 4A is a cross-sectional view of an environmentally sensitive electronic device package according to a second embodiment of the disclosure.

FIG. 4B is a partial top view of the environmentally sensitive electronic device package in FIG. 4A.

FIG. 4C is a cross-sectional view of a side wall barrier according to the second embodiment of the disclosure.

FIG. 5 is a cross-sectional view of an environmentally sensitive electronic device package according to a third embodiment of the disclosure.

FIG. 6 is a cross-sectional view of an environmentally sensitive electronic device package according to a fourth embodiment of the disclosure.

FIG. 7 is a cross-sectional view of an environmentally sensitive electronic device package according to a fifth embodiment of the disclosure.

FIGS. 8A-FIG. 8E, FIG. 8C', and FIG. 8D' are diagrams illustrating a manufacturing method of an environmentally sensitive electronic device package according to the disclosure.

FIG. 9 is a diagram illustrating a roll-to-roll manufacturing process of a functional film according to a sixth embodiment of the disclosure.

FIG. 10 is a diagram illustrating a roll-to-roll manufacturing process of an environmentally sensitive electronic device package according to a seventh embodiment of the disclosure.

## DETAILED DESCRIPTION OF DISCLOSED EMBODIMENTS

[First Embodiment]

FIG. 1A is a cross-sectional view of a functional film according to the first embodiment of the disclosure. Referring to FIG. 1A, the functional film 100 in the present embodiment includes an adhesive 110, at least one side wall barrier 120, a



first de-bonding film 130, and a second de-bonding film 140. The adhesive 110 has a first surface 110a and a second surface 110b opposite to the first surface 110a. The side wall barrier 120 is distributed in the adhesive 110. The first de-bonding film 130 is adhered with the first surface 110a. The second de-bonding film 140 is adhered with the second surface 110b. Generally, the first de-bonding film 130 and the second de-bonding film 140 of the functional film 100 can be respectively removed from the first surface 110a and the second surface 110b of the adhesive 110 by applying appropriate forces. In the present embodiment, the adhesive 110 may be an optical adhesive of a specific transmission. However, in the present embodiment, the adhesive 110 may also be a reflective adhesive or a transfective adhesive. To be specific, the adhesive 110 may be made of epoxy, acrylic compound, or silicone. In the present embodiment, the adhesive 110 may be made of a material which can be cured through heating or light irradiation. In other words, the adhesive 110 may be made of a material that is not yet cured through heating or light irradiation. The side wall barrier 120 may be made of a metal or a metal oxide. The first de-bonding film 130 and the second de-bonding film 140 may be made of parylene. The first de-bonding film 130 and the second de-bonding film 140 are respectively adhered with the first surface 110a and the second surface 110b of the adhesive 110 to prevent the adhesive 110 from being contaminated by external impurities. Additionally, in the present embodiment, the first de-bonding film 130 has an alignment mark 130a. The alignment mark 130a is located outside the distribution area of the adhesive 110. However, the disclosure is not limited thereto, and in other embodiments, the alignment mark 130a may also be completely or partially covered by the adhesive 110. The alignment mark 130a ensures the position of the adhesive 110 on the first de-bonding film 130 and diminishes misalignment. Additionally, the alignment mark 130a facilitates subsequent processes.

Even though the present embodiment is described by taking the functional film 100 having both the first de-bonding film 130 and the second de-bonding film 140 as an example, in other embodiments, the functional film 100 may also have only one de-bonding film. In other words, the functional film 100 may have only the first de-bonding film 130 or only the second de-bonding film 140.

FIG. 1B is a top view of the functional film in FIG. 1A. Referring to FIG. 1B, in the present embodiment, the side wall barrier 120 may be a continuous pattern formed in the adhesive 110. For example, the side wall barrier 120 in the present embodiment may be a close continuous quadrangular pattern. However, in other embodiments of the disclosure, the side wall barrier 120 may also be a discontinuous pattern (not shown, for example, a discontinuous quadrangular pattern) formed in the adhesive 110. However, in the disclosure, the side wall barrier 120 is not limited to a quadrangular pattern, and other types of patterns may also be applied to the disclosure.

Referring to FIG. 1A again, in the present embodiment, when the side wall barrier 120 is pressed and implanted into the adhesive 110, at least a part of the side wall barrier 120 is not in contact with the first de-bonding film 130. In addition, when the second de-bonding film 140 is adhered with the adhesive 110, at least a part of the side wall barrier 120 is not in contact with the second de-bonding film 140. It should be noted that the contact extent (i.e., the size of the contact area) between the side wall barrier 120 and the first de-bonding film 130 and/or the second de-bonding film 140 is related to the process control. Because the implanted depth and position of the side wall barrier 120 cannot be precisely controlled and

the height of the side wall barrier 120 and the thickness of the adhesive 110 come with certain errors, when different parts of the functional film 100 are observed, the side wall barrier 120 may be floated in the adhesive 110 and not in contact with the first de-bonding film 130 and/or the second de-bonding film 140, the side wall barrier 120 may be in contact with only the first de-bonding film 130 or the second de-bonding film 140, or the side wall barrier 120 may be in contact with both the first de-bonding film 130 and the second de-bonding film 140. Additionally, the section of the side wall barrier 120 in the present embodiment may be a quadrangular section (as shown in FIG. 1A). However, the disclosure is not limited thereto, and the cross-section of the side wall barrier 120 may also be a polygonal section, a circular section, or an oval section.

FIG. 2A is a cross-sectional view of another functional film according to the first embodiment of the disclosure, and FIG. 2B is a top view of the functional film in FIG. 2A. Referring to FIG. 2A and FIG. 2B, the functional film 100A in FIG. 2A is similar to the functional film 100 in FIG. 1A except that the adhesive 110 in the present embodiment includes a plurality of adhesive segments 112 arranged in an array, wherein the adhesive segments 112 are separated from each other. In addition, the side wall barrier 120 may be respectively distributed in the adhesive segments 112 through a compression implantation technique.

Below, different manufacturing methods of a functional film will be described with reference to FIGS. 3A-3C and FIGS. 3A'-3C'. It should be noted that throughout the embodiments, like reference numerals refer to the like elements and descriptions thereof are omitted.

FIGS. 3A-3C are diagrams illustrating a manufacturing method of the functional film in FIG. 1A. Referring to FIG. 3A, first, the adhesive 110 is formed on the first de-bonding film 130. The first de-bonding film 130 has an alignment mark 130a, and the adhesive 110 may be supplied and coated on the first de-bonding film 130 through a dispensing head 30. For example, the adhesive 110 does not cover the alignment mark 130a, and accordingly the alignment mark 130a is located outside the distribution area of the adhesive 110. However, the disclosure is not limited thereto, and the distribution area of the adhesive 110 may also completely or partially cover the alignment mark 130a. The alignment mark 130a ensures that the dispensing head 30 supplies the adhesive 110 at the correct position on the first de-bonding film 130.

Referring to FIG. 3B, the side wall barrier 120 is then formed in the adhesive 110. The side wall barrier 120 may be picked up by a gauge 40 and then implanted into the adhesive 110 by the gauge 40 through a compression implantation technique. When the side wall barrier 120 is implanted into the adhesive 110, at least a part of the side wall barrier 120 is not in contact with the first de-bonding film 130.

Referring to FIG. 3C, the second de-bonding film 140 is adhered with the adhesive 110 so that the adhesive 110 is between the first de-bonding film 130 and the second de-bonding film 140. In other words, the first de-bonding film 130 and the second de-bonding film 140 are respectively adhered with two opposite surfaces of the adhesive 110. When the second de-bonding film 140 is adhered with the adhesive 110, at least a part of the side wall barrier 120 is not in contact with the second de-bonding film 140. When different parts of the functional film 100 are observed, the side wall barrier 120 may be floated in the adhesive 110 and not in contact with the first de-bonding film 130 and/or the second de-bonding film 140, the side wall barrier 120 may be in contact with only the first de-bonding film 130 or the second de-bonding film 140, or the side wall barrier 120 may be in

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contact with both the first de-bonding film 130 and the second de-bonding film 140. The manufacturing the functional film 100 is completed after the manufacturing steps illustrated in FIGS. 3A-3C are sequentially executed.

Even though the present embodiment is described by taking the manufacturing method of the functional film 100 which has both the first de-bonding film 130 and the second de-bonding film 140 as an example, in other embodiments, the functional film 100 may also have only one de-bonding film. To be specific, the adhesive 110 is only formed on the first de-bonding film 130, and then the side wall barrier 120 is formed in the adhesive 110. Namely, the manufacturing of the functional film 100 having only the first de-bonding film 130 is completed after the manufacturing steps illustrated in FIGS. 3A-3B are sequentially executed. In another embodiment, the functional film 100 may also have only the second de-bonding film 140.

FIGS. 3A'-3C' are diagrams illustrating a manufacturing method of the functional film in FIG. 2A. Referring to FIG. 3A', first, the adhesive segments 112 are formed on the first de-bonding film 130. The first de-bonding film 130 has an alignment mark 130a, and the adhesive segments 112 may be supplied and coated on the first de-bonding film 130 through the dispensing head 30. For example, the distribution area of the adhesive segments 112 does not cover the alignment mark 130a, and accordingly the alignment mark 130a is located outside the distribution area of the adhesive segments 112. However, the disclosure is not limited thereto, and the distribution area of the adhesive segments 112 may also completely or partially cover the alignment mark 130a. In addition, as shown in FIG. 3A', the adhesive segments 112 in the present embodiment are arranged in an array and are separated from each other. Next, referring to FIG. 3B', the side wall barrier 120 is formed in the adhesive segments 112. The side wall barrier 120 may be picked up by the gauge 40 and then respectively implanted into the corresponding adhesive segments 112 by the gauge 40 through a compression implantation technique. When the side wall barrier 120 is implanted into the corresponding adhesive segments 112, at least a part of the side wall barrier 120 is not in contact with the first de-bonding film 130.

Finally, referring to FIG. 3C', the second de-bonding film 140 is adhered with the adhesive segments 112 so that the adhesive segments 112 are between the first de-bonding film 130 and the second de-bonding film 140. In other words, the first de-bonding film 130 and the second de-bonding film 140 are respectively adhered with two opposite surfaces of the adhesive segments 112. When the second de-bonding film 140 is adhered with the adhesive segments 112, at least a part of the side wall barrier 120 is not in contact with the second de-bonding film 140. The manufacturing of the functional film 100A is completed after the manufacturing steps illustrated in FIGS. 3A'-3C' are sequentially executed.

Even though the present embodiment is described by taking the manufacturing method of the functional film 100A which has both the first de-bonding film 130 and the second de-bonding film 140 as an example, in other embodiments, the functional film 100A may also have a single de-bonding film. To be specific, the adhesive segments 112 may be formed only on the first de-bonding film 130, and then the side wall barrier 120 is formed in the adhesive segments 112. Namely, the manufacturing of the functional film 100A having only the first de-bonding film 130 is completed after the manufacturing steps illustrated in FIGS. 3A'-3B' are sequentially executed. In another embodiment, the functional film 100A may also have only the second de-bonding film 140.

[Second Embodiment]

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FIG. 4A is a cross-sectional view of an environmentally sensitive electronic device package according to the second embodiment of the disclosure. Referring to FIG. 4A, the environmentally sensitive electronic device package 200 in the present embodiment includes a first adhesive 210, at least one first side wall barrier 220, a first substrate 230, and a second substrate 240. The first adhesive 210 has a first surface 210a and a second surface 210b opposite to the first surface 210a. The first side wall barrier 220 is distributed in the first adhesive 210. The first substrate 230 is bonded with the first surface 210a, wherein an environmentally sensitive electronic device 20 is disposed on the first substrate 230, and the environmentally sensitive electronic device 20 may be surrounded or not surrounded by the first side wall barrier 220. The second substrate 240 is bonded with the second surface 210b. Through the disposition of the first adhesive 210 and the first side wall barrier 220, moisture and oxygen can be effectively obstructed from entering, and accordingly the lifespan of the environmentally sensitive electronic device 20 can be effectively prolonged.

In the present embodiment, the first adhesive 210 may be made of epoxy, acrylic compound, or silicone. The first adhesive 210 may be made of a material which is cured through heating or light irradiation. Besides, the first adhesive 210 is well bonded with the first substrate 230 and the second substrate 240 and no de-lamination will occur. Thus, moisture and oxygen can be effectively obstructed from entering. The first side wall barrier 220 may be made of a metal or a metal oxide. The first substrate 230 and the second substrate 240 may be flexible substrates made of PE plastic, PMMA, polycarbonate (PC), or polyimide (PI). For example, aforementioned PE plastic may be PEC, PEN, or PES flexible plastic. However, the disclosure is not limited thereto, and the flexible substrates may also be made of metals.

In addition, the environmentally sensitive electronic device 20 may be an active environmentally sensitive display device or a passive environmentally sensitive display device. The active environmentally sensitive display device may be an active matrix organic light emitting diode (AM-OLED), and the passive environmentally sensitive display device may be a passive matrix organic light emitting diode (PM-OLED).

In addition, the first substrate 230 in the present embodiment has an alignment mark 230a. The second substrate 240 can be adhered with the first adhesive 210 by using the alignment mark 230a as a reference point, so that the accuracy of alignment between the first substrate 230 and the second substrate 240 can be improved. The alignment mark 230a is outside the distribution area of the first adhesive 210. However, the disclosure is not limited thereto, and in other embodiments, the alignment mark 230a may also be completely or partially covered by the first adhesive 210.

FIG. 4B is a partial top view of the environmentally sensitive electronic device package in FIG. 4A, and FIG. 4C is a cross-sectional view of another side wall barrier according to the second embodiment of the disclosure. Referring to FIG. 4B, the first side wall barrier 220 in the present embodiment may be a continuous pattern (for example, a close continuous quadrangular pattern) formed in the first adhesive 210. Referring to FIG. 4C, in another embodiment of the disclosure, the first side wall barrier 220 is a discontinuous pattern (for example, a discontinuous quadrangular pattern) formed in the first adhesive 210. However, the first side wall barrier 220 is not limited to a quadrangular pattern in the disclosure, and other types of patterns may also be adopted in the disclosure.

Referring to FIG. 4A again, in the present embodiment, when the first side wall barrier 220 is pressed and implanted into the first adhesive 210, at least a part of the first side wall

barrier 220 is not in contact with the first substrate 230. In addition, when the second substrate 240 is bonded with the first adhesive 210, at least a part of the first side wall barrier 220 is not in contact with the second substrate 240. It should be noted that the contact extent (i.e., the size of the contact area) between first side wall barrier 220 and the first substrate 230 and/or the second substrate 240 is related to the process control. Because the implanted depth and position of the first side wall barrier 220 cannot be precisely controlled and the height of the first side wall barrier 220 and the thickness of the first adhesive 210 come with certain errors, when different parts of the first adhesive 210 are observed, the first side wall barrier 220 may be floated in the first adhesive 210 and not in contact with the first substrate 230 and/or the second substrate 240, the first side wall barrier 220 may be in contact with only the first substrate 230 or the second substrate 240, or the first side wall barrier 220 may be in contact with both the first substrate 230 and the second substrate 240. Additionally, the section of the first side wall barrier 220 in the present embodiment may be a quadrangular section. However, the disclosure is not limited thereto, and the cross-section of the first side wall barrier 220 may also be a polygonal section, a circular section, or an oval section.

Below, different types of environmentally sensitive electronic device packages will be described with reference to FIG. 5 (the third embodiment) to FIG. 7 (the fifth embodiment). It should be noted that throughout following embodiments, like reference numerals refer to the like elements and descriptions thereof are omitted.

[Third Embodiment]

FIG. 5 is a cross-sectional view of an environmentally sensitive electronic device package according to the third embodiment of the disclosure. Referring to FIG. 4A and FIG. 5, the environmentally sensitive electronic device package 300 in the present embodiment is similar to the environmentally sensitive electronic device package 200 in the second embodiment (i.e., FIG. 4A) except that the environmentally sensitive electronic device package 300 in the present embodiment further includes a second adhesive 310, a second side wall barrier 320, and a third substrate 330. The second adhesive 310 is disposed on the external surface of the first substrate 230 so that the first substrate 230 is between the first adhesive 210 and the second adhesive 310. The second side wall barrier 320 is distributed in the second adhesive 310. The third substrate 330 is disposed on the second adhesive 310 so that the second adhesive 310 is between the first substrate 230 and the third substrate 330. Through the disposition of the second adhesive 310, the second side wall barrier 320, and the third substrate 330, moisture and oxygen can be effectively obstructed from entering. Namely, the moisture and oxygen obstruction capability of the first substrate 230 is enhanced, so that the lifespan of the environmentally sensitive electronic device 20 is effectively prolonged.

In the present embodiment, the second adhesive 310 may be made of epoxy, acrylic compound, or silicone. The second adhesive 310 may be made of a material which is cured through heating or light irradiation. Besides, the second adhesive 310 is well bonded with the first substrate 230 and the third substrate 330 and no de-lamination will occur. Thus, moisture and oxygen can be effectively obstructed from entering. The second side wall barrier 320 may be made of a metal or a metal oxide. The third substrate 330 may be a flexible substrate made of PE plastic, PMMA, PC, or PI. For example, aforementioned PE plastic may be PEC, PEN, or PES flexible plastic. However, the disclosure is not limited thereto, and the flexible substrate may also be made of a metal.

In the present embodiment, the contact extent (i.e., the size of the contact area) between the second side wall barrier 320 and the first substrate 230 and/or the third substrate 330 is related to the process control. Because the implanted depth and position of the second side wall barrier 320 cannot be precisely controlled and the height of the second side wall barrier 320 and the thickness of the second adhesive 310 come with certain errors, when different parts of the second adhesive 310 are observed, the second side wall barrier 320 may be floated in the second adhesive 310 and not in contact with the first substrate 230 and/or the third substrate 330, the second side wall barrier 320 may be in contact with only the first substrate 230 or the third substrate 330, or the second side wall barrier 320 may be in contact with both the first substrate 230 and the third substrate 330.

[Fourth Embodiment]

FIG. 6 is a cross-sectional view of an environmentally sensitive electronic device package according to the fourth embodiment of the disclosure. Referring to FIG. 4A and FIG. 6, the environmentally sensitive electronic device package 400 in the present embodiment is similar to the environmentally sensitive electronic device package 200 in the second embodiment (i.e., FIG. 4A) except that the environmentally sensitive electronic device package 400 in the present embodiment further includes a third adhesive 410, a third side wall barrier 420, and a fourth substrate 440. The third adhesive 410 is disposed on the external surface of the second substrate 240 so that the third adhesive 410 is between the second substrate 240 and the fourth substrate 440. The third side wall barrier 420 is distributed in the third adhesive 410. The third substrate 330 is disposed on the third adhesive 410 so that the third adhesive 410 is between the second substrate 240 and the fourth substrate 440. Through the disposition of the third adhesive 410, the third side wall barrier 420, and the fourth substrate 440, moisture and oxygen can be effectively obstructed from entering. Namely, the moisture and oxygen obstruction capability of the second substrate 240 is enhanced, so that the lifespan of the environmentally sensitive electronic device 20 is effectively prolonged.

In the present embodiment, the third adhesive 410 may be made of epoxy, acrylic compound, or silicone. The third adhesive 410 may be made of a material which is cured through heating or light irradiation. Besides, the third adhesive 410 is well bonded with the second substrate 240 and the fourth substrate 440 and no de-lamination will occur. Thus, moisture and oxygen can be effectively obstructed from entering. The third side wall barrier 420 may be made of a metal or a metal oxide. The fourth substrate 440 may be a flexible substrate made of PE plastic, PMMA, PC, or PI. For example, aforementioned PE plastic may be PEC, PEN, or PES flexible plastic. However, the disclosure is not limited thereto, and the flexible substrate may also be made of a metal.

In the present embodiment, the contact extent (i.e., the size of the contact area) between the third side wall barrier 420 and the second substrate 240 and/or the fourth substrate 440 is related to the process control. Because the implanted depth and position of the third side wall barrier 420 cannot be precisely controlled and the height of the third side wall barrier 420 and the thickness of the third adhesive 410 come with certain errors, when different parts of the third adhesive 410 are observed, the third side wall barrier 420 may be floated in the third adhesive 410 and not in contact with the second substrate 240 and the fourth substrate 440, the third side wall barrier 420 may be in contact with only the second substrate 240 or the fourth substrate 440, or the third side wall

barrier **420** may be in contact with both the second substrate **240** and the fourth substrate **440**.  
[Fifth Embodiment]

FIG. 7 is a cross-sectional view of an environmentally sensitive electronic device package according to the fifth embodiment of the disclosure. Referring to FIG. 5 and FIG. 7, the environmentally sensitive electronic device package **500** in the present embodiment is similar to the environmentally sensitive electronic device package **300** in the third embodiment (i.e., FIG. 5) except that the environmentally sensitive electronic device package **500** in the present embodiment further includes a third adhesive **410**, a third side wall barrier **420**, and a fourth substrate **440**. The third adhesive **410** is disposed on the external surface of the second substrate **240**, so that the third adhesive **410** is between the second substrate **240** and the fourth substrate **440**. The third side wall barrier **420** is distributed in the third adhesive **410**. The third substrate **330** is disposed on the third adhesive **410**, so that the third adhesive **410** is between the second substrate **240** and the fourth substrate **440**. Through the disposition of the second adhesive **310**, the second side wall barrier **320**, the third substrate **330**, the third adhesive **410**, the third side wall barrier **420**, and the fourth substrate **440**, moisture and oxygen can be effectively obstructed from entering. Namely, the moisture and oxygen obstruction capability of the first substrate **230** and the second substrate **240** is enhanced, so that the lifespan of the environmentally sensitive electronic device **20** is effectively prolonged.

Below, manufacturing methods of different types of environmentally sensitive electronic device packages will be described with reference to FIGS. 8A-8E, FIG. 8C', and FIG. 8D'.

FIGS. 8A-FIG. 8E, FIG. 8C', and FIG. 8D' are diagrams illustrating a manufacturing method of an environmentally sensitive electronic device package according to the disclosure. Referring to FIG. 8A, first, the first adhesive **210** is formed on the first substrate **230**, wherein a first side wall barrier **220** is already formed in the first adhesive **210**. The first side wall barrier **220** may surround or may not surround the environmentally sensitive electronic device **20**, and at least part of the first side wall barrier **220** is not in contact with the first substrate **230**. To be specific, in the present embodiment, the first de-bonding film **130** of the functional film **100** in FIG. 1A can be removed by applying an appropriate force, so that the adhesive **110** is adhered with the internal surface of the first substrate **230** on which the environmentally sensitive electronic device **20** is disposed. In the present embodiment, the first substrate **230** has an alignment mark **230a** such that the accuracy of alignment between the first substrate **230** and the second substrate **240** is improved. The alignment mark **230a** is located outside the distribution area of the first adhesive **210**. However, the disclosure is not limited thereto, and the alignment mark **230a** may be completely or partially covered by the first adhesive **210**. It should be noted that the coating of the first adhesive **210** formed on the first substrate **230** is not limited to the tape coating technique described above. The adhesive segments **112** shown in FIG. 2A and FIG. 2B may also be coated on the formed on the first substrate **230**.

Next, referring to FIG. 8B, the second substrate **240** is adhered with the first adhesive **210** so that the first adhesive **210** is located between the first substrate **230** and the second substrate **240**. To be specific, in the present embodiment, the second de-bonding film **140** of the functional film **100** in FIG. 1A can be removed by applying an appropriate force, so as to expose another surface of the functional film **100** and adhere the second substrate **240** with the surface of the adhesive **110**

originally covered by the second de-bonding film **140**. After that, the adhesive **110** is, for example, cured through heating or ultraviolet irradiation to form the first adhesive **210**. This first adhesive **210** is well bonded with the first substrate **230** and the second substrate **240**. However, in the present embodiment, the second substrate **240** may also be directly adhered with the first adhesive **210** in FIG. 8A', and the first adhesive **210** is, for example, then cured through heating or ultraviolet irradiation so that the first adhesive **210** is well bonded with the first substrate **230** and the second substrate **240**. After the second substrate **240** is bonded with the first adhesive **210**, at least a part of the first side wall barrier **220** is not in contact with the second substrate **240**. When different parts of the environmentally sensitive electronic device package are observed, the first side wall barrier **220** may be floated in the adhesive **210** and not in contact with the first substrate **230** and/or the second substrate **240**, the first side wall barrier **220** may be in contact with only the first substrate **230** or the second substrate **240**, or the first side wall barrier **220** may be in contact with both the first substrate **230** and the second substrate **240**.

According to the disclosure, after the steps illustrated in FIGS. 8A-8B are executed, the manufacturing of multiple environmentally sensitive electronic device packages **200** can be accomplished through a unitization process (for example, a laser cutting process or a mechanical cutting process).

Referring to FIG. 8C and FIG. 8D, according to the disclosure, after the steps illustrated in FIGS. 8A-8B are executed, the second adhesive **310** and the third substrate **330** are further formed on the external surface of the first substrate **230**, wherein a second side wall barrier **320** is already formed in the second adhesive **310**. It should be noted that in the present embodiment, the technique of forming the second adhesive **310** is similar to that of forming the first adhesive **210**. The bonding between the third substrate **330** and the second adhesive **310** is the same as that between the first substrate **230** and the first adhesive **210**. Therefore, descriptions of the bonding between the third substrate **330** and the second adhesive **310** are omitted.

According to the disclosure, after the steps illustrated in FIG. 8C and FIG. 8D are executed, the manufacturing of multiple environmentally sensitive electronic device packages **300** can be accomplished through a unitization process (for example, a laser cutting process or a mechanical cutting process).

Referring to FIG. 8C' and FIG. 8D', according to the disclosure, after the steps illustrated in FIGS. 8A-8B are executed, the third adhesive **410** and the fourth substrate **440** are further formed on the external surface of the second substrate **240**, wherein a third side wall barrier **420** is already formed in the third adhesive **410**. It should be noted that in the present embodiment, the technique of forming the third adhesive **410** is similar to that of forming the first adhesive **210** and the bonding between the fourth substrate **440** and the third adhesive **410** is the same as the bonding between the first substrate **230** and the first adhesive **210**. Therefore, descriptions of the bonding between the third substrate **330** and the second adhesive **310** are omitted.

According to the disclosure, after the steps illustrated in FIG. 8C' and FIG. 8D' are executed, the manufacturing of multiple environmentally sensitive electronic device packages **400** can be accomplished through a unitization process (for example, a laser cutting process or a mechanical cutting process).

Thereafter, referring to FIG. 8E, according to the disclosure, the second adhesive **310** and the third substrate **330** are formed on the external surface of the first substrate **230** at the

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same time, and the third adhesive **410** and the fourth substrate **440** are formed on the external surface of the second substrate **240**.

According to the disclosure, after the step illustrated in FIG. **8E** is executed, the manufacturing of multiple environmentally sensitive electronic device packages **500** can be accomplished through a unitization process (for example, a laser cutting process or a mechanical cutting process).

Besides the manufacturing methods of functional films and environmentally sensitive electronic device packages described above, according to the disclosure, the functional films and the environmentally sensitive electronic device packages may also be manufactured through other techniques. Below, the techniques of manufacturing a functional film and an environmentally sensitive electronic device package by using a roll-to-roll equipment will be respectively described with reference to FIG. **9** (the sixth embodiment) and FIG. **10** (the seventh embodiment). It should be noted that throughout the embodiments, like reference numerals refer to the like elements and descriptions thereof are omitted.

[Sixth Embodiment]

FIG. **9** is a diagram illustrating a roll-to-roll manufacturing process of a functional film according to the sixth embodiment of the disclosure. Referring to FIG. **9**, in the present embodiment, the first de-bonding film **130** is furled into a structure roll **S1**, and the second de-bonding film **140** is furled into a structure roll **S2**. The first de-bonding film **130** is driven by a wheel **50a** and a wheel **50b** and is released from the structure roll **S1**. Through the driving of a wheel **52a** and a wheel **52b**, the first de-bonding film **130** is continuously conveyed, so that the adhesive **110** can be coated on the first de-bonding film **130**. Some of the wheels **50a**, **50b**, **52a**, and **52b** are driving wheels, while the rest are idler wheel. A driving wheel offers a driving force, while an idler wheel is capable of guiding the convey direction.

The first de-bonding film **130** has an alignment mark **130a**. When the first de-bonding film **130** is conveyed, the adhesive **110** is supplied and coated on the first de-bonding film **130** through a dispensing head **30**. For example, because the distribution area of the adhesive **110** does not cover the alignment mark **130a**, the alignment mark **130a** is located outside the distribution area of the adhesive **110**. However, the adhesive may also completely or partially cover the alignment mark **130a**.

After the adhesive **110** is coated, a side wall barrier **120** is formed in the adhesive **110**. The side wall barrier **120** may be picked up by a gauge **40** and then implanted into the adhesive **110** by the gauge **40** through a compression implantation technique. When the side wall barrier **120** is implanted into the adhesive **110**, at least a part of the side wall barrier **120** is not in contact with the first de-bonding film **130**. The adhesive **110** with the side wall barrier **120** and the first de-bonding film **130** are continuously conveyed to pass through between the wheel **52a** and the wheel **52b**. The second de-bonding film **140** is driven by the wheel **52a** and the wheel **52b** and is released from the structure roll **S2**. Through the driving of the wheel **52a** and the wheel **52b**, the second de-bonding film **140** is pressed on the adhesive **110** so that the adhesive **110** is between the first de-bonding film **130** and the second de-bonding film **140**. In other words, the first de-bonding film **130** and the second de-bonding film **140** are respectively adhered with two opposite surfaces of the adhesive **110**. When the second de-bonding film **140** is adhered with the adhesive **110**, at least a part of the side wall barrier **120** is not in contact with the second de-bonding film **140**. By now, the manufacturing of the functional film **100** is approximately completed. Thereafter, the functional film **100** can be furled

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into a structure roll **S3** such that the structure roll **S3** can be easily used in subsequent processes. It should be noted that the coating of the adhesive **110** over the first de-bonding film **130** is not limited to the tape coating technique described above. The adhesive segments **112** may also be coated on the first de-bonding film **130**, and the functional film **100A** in FIG. **2A** may be formed through the roll-to-roll manufacturing process mentioned above.

Even though the present embodiment is described by taking the roll-to-roll manufacturing method of the functional film **100** having both the first de-bonding film **130** and the second de-bonding film **140** as an example, in other applicable roll-to-roll manufacturing methods, the functional film **100** may also have only one de-bonding film. In other words, the adhesive **110** may be coated only on the first de-bonding film **130**. To be specific, the first de-bonding film **130** furled into the structure roll **S1** can be driven by the wheel **50a** and the wheel **50b** to be released from the structure roll **S1** and driven by the wheel **52a** and the wheel **52b** to be continuously conveyed, so that the adhesive **110** can be coated on the first de-bonding film **130**. When the first de-bonding film **130** is conveyed, the adhesive **110** is supplied and coated on the first de-bonding film **130** through the dispensing head **30**.

After the adhesive **110** is coated, the side wall barrier **120** is formed in the adhesive **110**. To be specific, the side wall barrier **120** is picked up by the gauge **40** and then implanted into the adhesive **110** by the gauge **40** through a compression implantation technique. The functional film **100** having only the first de-bonding film **130** can be further furled into a structure roll (not shown). In another embodiment, the structure roll (not shown) may also be the functional film **100** having only the second de-bonding film **140**.

In addition, the adhesive segments **112** may be formed on the first de-bonding film **130** or the second de-bonding film **140** only. After that, the side wall barrier **120** is formed in the adhesive segments **112**, and the functional film **100A** illustrated in FIG. **2A** is then formed through aforementioned roll-to-roll manufacturing process.

[Seventh Embodiment]

FIG. **10** is a diagram illustrating a roll-to-roll manufacturing process of an environmentally sensitive electronic device package according to the seventh embodiment of the disclosure. Referring to FIG. **9** and FIG. **10**, in the present embodiment, the functional film **100** is provided from the structure roll **S3** in FIG. **9**, the first substrate **230** is furled into a structure roll **S5**, and the second substrate **240** is furled into a structure roll **S7**.

In the present embodiment, first, the functional film **100** is driven by the wheel **60a** and the wheel **60b** to be released from the structure roll **S3**. The first de-bonding film **130** removed from the functional film **100** is driven by the wheel **62a** and the wheel **60b** such that the first de-bonding film **130** is furled into a structure roll **S4**. Besides, the functional film **100** without the first de-bonding film **130** (i.e., the adhesive **110** and the second de-bonding film **140**) is driven by the wheel **64a** and the wheel **62b** such that the adhesive **110** and the second de-bonding film **140** are continuously conveyed. The first substrate **230** is driven by the wheel **64a** and the wheel **62b** and is released from the structure roll **S5**. The first substrate **230** is laminated together with the adhesive **110** and the second de-bonding film **140** passing through between the wheel **64a** and the wheel **62b**, so that the adhesive **110** is adhered with the internal surface of the first substrate **230** having the environmentally sensitive electronic device **20** formed thereon. The first substrate **230** has an alignment mark **230a** such that the accuracy of alignment between the first substrate **230** and the second substrate **240** is improved. The

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alignment mark **230a** is located outside the distribution area of the first adhesive **210**. However, the adhesive may also completely or partially cover the alignment mark **130a**.

Thereafter, the laminated second de-bonding film **140**, adhesive **110**, and first substrate **230** are driven by the wheels **66a** and **66b** to pass through a first curing unit **80** (for example, a thermal heating unit or a ultraviolet curing unit), so that the adhesive **110** is cured to form the first adhesive **210** and the first adhesive **210** is well bonded with the first substrate **230** and is driven and continuously conveyed by the wheel **68a** and the wheel **68b**.

Next, the second substrate **240** is adhered with the first adhesive **210** such that the first adhesive **210** is located between the first substrate **230** and the second substrate **240**. To be specific, in the present embodiment, the second de-bonding film **140** can be removed from the first adhesive **210** by applying an appropriate force. The removed second de-bonding film **140** is driven by the wheel **66a** and the wheel **66b** and is furled into a structure roll **S6**. The second substrate **240** is driven by the wheels **68a** and **68b** and is released from the structure roll **S7**. The second substrate **240** is laminated with the first adhesive **210** and the first substrate **230** passing between the wheel **68a** and wheel **68b**, so that the first adhesive **210** is adhered with the internal surface of the second substrate **240**. Next, the laminated second substrate **240**, first adhesive **210**, and first substrate **230** are continuously conveyed to pass through a second curing unit **90** (for example, a thermal curing unit or a ultraviolet curing unit), so that the first adhesive **210** is well bonded with the second substrate **240** and the first substrate **230**. After the second substrate **240** is bonded with the first adhesive **210**, at least a part of the first side wall barrier **220** is not in contact with the second substrate **240**. It should be noted that in the present embodiment, the wheels **60a**, **60b**, **62a**, **62b**, **64a**, **64b**, **66a**, **66b**, **68a**, and **68b** include driving wheels and idler wheels. A driving wheel offers a driving force, while an idler wheel is capable of guiding the convey direction. However, the disclosure is not limited herein.

After the manufacturing method described above is completed, according to the disclosure, the functional film **100** can be furled into a structure roll **S8** such that the structure roll **S8** can be easily used in subsequent processes, or the functional film **100** can be singularized to form a plurality of environmentally sensitive electronic device packages **200** by a laser cutting process or a mechanical cutting process, for example. Of course, the structure roll **S8** can be used to complete the manufacturing method illustrated in FIG. **8C** and FIG. **8D**, FIG. **8C'**, and FIG. **8D'** or FIG. **8E** through a roll-to-roll manufacturing process the same as or similar to that in the present embodiment. In addition, the environmentally sensitive electronic device packages **300**, **400**, or **500** can be singularized by a laser cutting process or a mechanical cutting process, for example.

On the other hand, in other embodiments, the roll-to-roll manufacturing process of the environmentally sensitive electronic device package in the present embodiment can be further combined with the roll-to-roll manufacturing process of the functional film in the sixth embodiment. To be specific, after the functional film **100** in FIG. **9** is completed, the functional film **100** needs not to be furled into the structure roll **S3**. Instead, the functional film **100** is directly driven by the wheel **60a** and the wheel **60b** to go through the roll-to-roll manufacturing process illustrated in FIG. **10**, so as to manufacture an environmentally sensitive electronic device package **200**. However, the disclosure is not limited herein.

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As described above, an environmentally sensitive electronic device package provided by the disclosure offers good moisture and oxygen obstruction capability. Accordingly, the lifespan of an environmentally sensitive electronic device is effectively prolonged.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure cover modifications and variations of this disclosure provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An environmentally sensitive electronic device package, comprising:

a first adhesive having a first surface and a second surface opposite to the first surface;

at least one first side wall barrier distributed in the first adhesive, wherein the at least one first side wall barrier is floated in the adhesive;

a first substrate bonded with the first surface, wherein at least one environmentally sensitive electronic device is disposed on the first substrate; and

a second substrate bonded with the second surface, wherein the at least one first side wall barrier is not in contact with the first substrate and not in contact with the second substrate.

2. The environmentally sensitive electronic device package according to claim 1, wherein the environmentally sensitive electronic device is surrounded by the at least one first side wall barrier.

3. The environmentally sensitive electronic device package according to claim 1, wherein at least one of the first substrate and the second substrate has at least one alignment mark, and the alignment mark is located outside a distribution area of the first adhesive.

4. The environmentally sensitive electronic device package according to claim 1, wherein at least one of the first substrate and the second substrate has at least one alignment mark, and the alignment mark is completely or partially covered by a distribution area of the first adhesive.

5. The environmentally sensitive electronic device package according to claim 1, wherein the at least one first side wall barrier comprises a continuous pattern or a discontinuous pattern.

6. The environmentally sensitive electronic device package according to claim 1, wherein the cross-section of the at least one first side wall barrier comprises a polygonal section, a circular section, or an oval section.

7. The environmentally sensitive electronic device package according to claim 1 further comprising:

a second adhesive disposed on the first substrate, wherein the first substrate is located between the first adhesive and the second adhesive;

at least one second side wall barrier distributed in the second adhesive; and

a third substrate disposed on the second adhesive, wherein the second adhesive is located between the first substrate and the third substrate.

8. An environmentally sensitive electronic device package, comprising:

a first adhesive having a first surface and a second surface opposite to the first surface;

at least one first side wall barrier distributed in the first adhesive;

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a first substrate bonded with the first surface, wherein at least one environmentally sensitive electronic device is disposed on the first substrate;  
 a second substrate bonded with the second surface;  
 a second adhesive disposed on the first substrate, wherein the first substrate is located between the first adhesive and the second adhesive;  
 at least one second side wall barrier distributed in the second adhesive;  
 a third substrate disposed on the second adhesive, wherein the second adhesive is located between the first substrate and the third substrate;  
 a third adhesive disposed on the second substrate, wherein the second substrate is located between the first adhesive and the third adhesive;  
 at least one third side wall barrier distributed in the third adhesive; and  
 a fourth substrate disposed on the third adhesive, wherein the third adhesive is located between the second substrate and the fourth substrate.

9. The environmentally sensitive electronic device package according to claim 8, wherein at least a part of the at least one first side wall barrier is in contact with the first substrate or the second substrate.

10. The environmentally sensitive electronic device package according to claim 8, wherein at least a part of the at least one first side wall barrier is in contact with both the first substrate and the second substrate.

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11. An environmentally sensitive electronic device package, comprising:

a first adhesive having a first surface and a second surface opposite to the first surface;

at least one first side wall barrier distributed in the first adhesive;

a first substrate bonded with the first surface, wherein at least one environmentally sensitive electronic device is disposed on the first substrate;

a second substrate bonded with the second surface;

a third adhesive disposed on the second substrate, wherein the second substrate is located between the first adhesive and the third adhesive;

at least one third side wall barrier distributed in the third adhesive; and

a fourth substrate disposed on the third adhesive, wherein the third adhesive is located between the second substrate and the fourth substrate.

12. The environmentally sensitive electronic device package according to claim 11, wherein at least a part of the at least one first side wall barrier is in contact with the first substrate or the second substrate.

13. The environmentally sensitive electronic device package according to claim 11, wherein at least a part of the at least one first side wall barrier is in contact with both the first substrate and the second substrate.

\* \* \* \* \*